Asia-Pacific
Economic Cooperation

Advancing Free Trade
for Asia-Pacific Prosperity

APEC Workshop on District Cooling and/or Heating Systems

APEC Energy Working Group

January 2023

APEC Workshop on District Cooling and/or Heating Systems

SUMMARY REPORT

APEC Energy Working Group

January 2023

APEC Project: EWG 08 2019S

Produced by
Hong Kong, China
Electrical and Mechanical Services Department

For
Asia Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 600
Email: info@apec.org
Website: www.apec.org

APEC#223-RE-04.1

Contents

1. Background

Asia-Pacific Economic Cooperation (APEC) Workshop on District Cooling and/or Heating Systems (DCHS) was held on 17 November 2020 alongside the Joint 55th Meeting of the APEC Expert Group on Energy Efficiency & Conservation (EGEE&C) and 31st Meeting of the APEC Expert Group on Energy Data and Analysis (EGEDA) held in Hong Kong, China on 19 to 20 November 2020. The workshop aimed to promote and highlight the growing importance of DCHS from the perspective of energy efficiency and conservation through the collection of DCHS data in driving progress towards meeting the APEC's energy intensity reduction goal.

2. Objective

The workshop was a half-day event conducted via a virtual platform in Hong Kong, China alongside the Joint 55th EGEE&C and 31st EGEDA Meetings. The workshop enhanced participants' understanding of the contribution of DCHS to energy intensity reduction, best practices of DCHS, challenges and application of innovative technologies. Furthermore, the experience shared by regulators, experts, international organisations, designers and operators during the workshop provided a platform for dialogue between APEC member economies to map out guidelines for the implementation of DCHS and achieve the APEC goal of energy intensity reduction. The DCHS workshop agenda is attached in Appendix A.

The workshop agenda comprised the following topics:

1. Development of DCHS
2. Technology and operation experience
3. Global experience and challenges

There were thirteen (13) speakers and over one hundred and ten (110) participants from fifteen (15) APEC member economies, including EWG representatives, EGEE&C members, EGEDA members, and non-members from relevant sectors, attending this online workshop. The participants were from Australia; Brunei Darussalam; Canada; Chile; China; Hong Kong, China; Indonesia; Japan; Malaysia; Mexico; the Philippines; Singapore; Chinese Taipei; Thailand and the United States.

Over 20 per cent and 30 per cent of women speakers and participants, respectively, attended the workshop to demonstrate the equality of gender and women's contributions to this project.

3. Workshop Summary

3.1. Welcome Address

Presenter: Mr POON Kwok Ying, Raymond, Assistant Director of Electrical and Mechanical Services Department, the Government of the Hong Kong Special Administrative Region, Hong Kong, China

As one of the APEC members, Hong Kong, China (HKC) initiated this project to support the Energy Working Group (EWG)'s strategy plan by promoting the implementation of DCHS to move towards energy intensity reduction and combat climate change. This self-funded project started in 2019 and valuable experience to share among APEC members during the workshop. DCHS can help to save energy and reduce peak power requirements due to the economy of scale and load diversity. Worldwide experience reveals that energy saving can be more than 30%. By integrating renewable energy or reclaimed energy in the central plant, DCHS can help a city move towards carbon neutrality. Besides, cooling or heating plant space can be released from buildings for different usages, such as green roofs and solar panels. Also, heat island effects commonly seen in congested central city areas will be mitigated. With all the advantages that DCHS could provide, it has been extensively adopted and implemented worldwide. DCHS is particularly suitable for new or redevelopment areas. There would be fewer site constraints and implementation of DCHS could be much more cost-effective if started from the town planning stage.

The district cooling plant in Dubai is a good example. By chilled water network of three DCS plants, currently provides 150,000 tons to support the cooling capacity of the downtown district. And much more plants will be built and the ultimate total capacity of the city's district cooling scheme will be over 1.3 million tons from 83 plants, which is 16 times the scale of the existing DCS in the Kai Tak area (counting South & North plants of 81,000 tons only) of HKC.

The District Cooling Systems (DCS) at Kai Tak Development (KTD) of HKC makes use of the nearby natural resource (i.e. seawater) as a heat rejection medium to reduce operation costs and enhance system efficiency. It can re-direct the surrounding seawater flowing through the seawater intake and outfall pipes, which also improves the water quality of the Kai Tak Approach Channel at the inner seawater area simultaneously.

The DCS in HKC was shortlisted among the three finalists in the "Green Technologies" category of the C40 Cities Bloomberg Philanthropies Awards with the theme "The Future We Want". This award aimed to recognise cities that played a leading role in climate actions, achieving sustainable development and inspiring other cities by showcasing their success stories. The DCS in HKC is also featured in Cities the 100 during the C40 Mayors Summit 2019 as one of the final 100 city ground-breaking solutions to the climate change problems. With the successful implementation of the first DCS in HKC, the Government is now exploring the implementation of DCS in more New Development Areas (NDA) with a planned total cooling capacity of about tripled the first DCS at Kai Tak Area.

Besides DCHS, there is further potential for innovative ways to save more energy. For example, implementation regasification of Liquefied Natural Gas (LNG) is an endothermic process that needs to absorb a large amount of heat energy and cool down its surroundings. So, the LNG regasification plant is a perfect partner for the DCHS plant. According to a study report on the potential of recovering cold energy from LNG regasification, a DCS using the cold energy derived from an LNG plant can reduce electricity consumption by more than 50% as compared with a traditional air conditioning system. Moreover, by analysing the DCHS operation data such as the outdoor temperature, change in cooling energy demand and efficiency of chiller equipment at various load levels, etc., the big data will be beneficial for predicting the most energy-saving mode of operation for optimisation. A similar approach has also been practised by the DCS in HKC since 2017 and successfully improved the system's efficiency by about 15%.

This workshop was a platform for sharing knowledge and experience in tackling the difficulties and challenges in DCHS. For example, under some extreme weather conditions such as super typhoons, the power supply stability may be affected and voltage drops can trip the equipment in the DCHS plant. In some cases where the DCHS plant is located near the sea, there might also be a risk of ingress of seawater affecting the DCHS operation. Another operation risk is the settlement of the DCHS piping network due to ground movement caused by construction works in the DCHS pipework vicinity. It is essential for early planning on emergency response procedures to ensure smooth DCHS plant operation.

In summary, DCHS is not only an energy-efficient way of providing space cooling and heating for space comfort, but it can also reduce pollution and provide green job opportunities. APEC would continue to be an effective platform for sharing the latest technology and development of DCHS and fostering closer communication amongst APEC member economies in the future.

3.2. Opening Remarks

Presenter: Mr HOU Jen-Yi, Expert Group on Energy Data and Analysis (EGEDA) Co-Chair

The globe is facing significant challenges brought by climate change. According to the Intergovernmental Panel on Climate Change (IPCC), there is an urgency to mitigate the situation. A target of net zero by 2050 has been agreed upon internationally. Although various economies have set their reduction targets, a technological breakthrough is a fundamental pillar to achieving the ambitious goal. Energy-efficient technology is one of the fundamental pillars of mitigation measures.

DCHS is one of the developed energy-efficient technologies and is widely adopted in the APEC region. While District Heating System (DHS) is adopted in economies with polar and dry climate zones, District Cooling System (DCS) is emerging among the economies with tropical and sub-tropical climate zones. The energy demand for space cooling will be increased dramatically from 2020 to 2025 in residential and service building sectors. DCS is an effective energy-efficient technology to provide space cooling.

Despite the increasing popularity of DCS, the data collection for DCS is the greatest challenge faced by the Expert Group on Energy Data and Analysis (EGEDA) today. From the energy statics and energy balance, there is still a lack of energy consumption data for analysing the efficiency of the DCS. The standardised methodology shall be investigated and agreed upon globally on the data flow and data availability. Energy agencies shall start collecting the data to stimulate policymakers to develop guidelines, and regulations to achieve energy reduction targets.

3.3. Session 1: A Study on District Cooling Systems in APEC: The Final Report

Presenter: Ms Elvira Torres GELINDON, Research Fellow ESTO, Asia Pacific Energy Research Centre (APERC)

District Cooling System Principle

District Cooling System (DCS) is a centralised system of production and distribution of chilled water to facilitate air conditioning in individual buildings within a designated district. DCS constitutes a new form of energy service. With the increasing demand for space cooling and DCS implementation, it is important to ensure that the data flow for space cooling is accounted for in energy statistics and energy balances.

Research of APERC for DCS

APERC has carried out a study to assess the DCS in selected APEC member economies and learn how the DCS consumption is reported. APERC has started to interview experts to investigate the methodology for energy measurement from DCS. Based on the available data from the APEC member economies, the cooling capacity of DCS in APEC regions reached around 25GW in 2019, with major installations in the United States and Japan.

District Cooling and District Heating

The production and delivery of the services of district cooling and district heating are comparable. Like DHS, the DCS shall be considered an energy transformation process. The energy or fuel inputted to the system, the production and the delivered services shall be all measurable. Excluding energy consumption associated with DCS's chilled water will result in an underestimated energy use intensity (EUI) for buildings.

Advantages of DCS

DCS can reduce environmental impacts with its higher energy efficiency, and centralised control and monitor chilled water and other chemicals compared with individual building cooling systems. With DCS, the chiller and most of the air conditioning equipment are not located in the individual building. Therefore, from the perspective of individual buildings and spaces, energy usage and maintenance costs will be reduced. Moreover, there is a potential for free cooling when DCS is adopted.

Data Collection for DCHS

Several economies have already been collecting energy consumption for cooling, but heat is overstated. Strong collaboration between government, energy statisticians, data users and providers shall be established to develop the methodology, guidelines and regulation of the data collection for DCHS.

APERC proposed the data collection for DCHS are shown in table 1-1.

Combined cooling and power plants or cogeneration	District cooling or heating only
• Fuel used to generate electricity • Electricity generated • Electricity used in electric chillers • Chilled water	• Energy inputs • Chilled water output and sold

Table 1-1 Data collection for DCHS

3.4. Session 2: Development of DCHS

3.4.1. Sharing 2-1: Planning & Implementation of District Cooling System in Hong Kong, China

Presenter: Ms Denise LO Kit Ying, Senior Engineer, Electrical and Mechanical Services Department, the Government of the Hong Kong Special Administrative Region, Hong Kong, China

Case Study - Kai Tak District Cooling System in Hong Kong, China

To air-conditioning buildings during HKC's hot, humid summers, the Government built a district cooling system to offer a cleaner and more sustainable alternative. A district cooling system (DCS) is a measure used in HKC to a reduction of energy usage toward carbon neutrality. DCS is a centralised air conditioning system of a very large scale. It consists of one or more chiller plants to produce chilled water and a closed-loop network of underground pipes for chilled water distribution. Chilled water is pumped to individual buildings for use in their air conditioning systems and is then returned to the central chiller plant for re-chilling.

The first-of-its-kind DCS in HKC is being developed in three phases at Kai Tak District (KTD) since 2011. The system will support about 1.73 million m^2 of non-domestic air-conditioned gross floor area, which requires about 284MW of refrigeration capacity. The construction works of Phases I, II and III (Package A) were completed in 2013, 2014 and 2017 respectively. The last phase of work (i.e. Phase III) was expected to be completed by the end of 2025. The operation of the DCS commenced in 2013. It is estimated that the maximum annual saving in electricity consumption arising from the entire DCS project would be 85 million kWh, or about a 35% reduction compared with the original estimated electricity consumption of 243 million kWh without the DCS. The corresponding reduction of carbon dioxide emission is 59,500 tonnes per annum.

The first DCS in HKC is located in the Kai Tak development district. Previously occupied as an airport, the Kai Tak development district is to be re-developed into the 2nd Central Business District of HKC, with mixed building types, including cruise terminals, hospitals, sports parks, office and retail buildings, etc. The Kai Tak DCS serves an air conditioning area of 1.73 million m^2 with a cooling capacity of 284MW, updated with an additional cooling capacity of 178MW to serve 0.81 million m^2 by 2028. The construction cost of the Kai Tak DCS is around USD 640 million (equivalent to HKD 4,945 million), with an estimated 85 million kWh of energy saved per year. The payback period is about 30 years.

Innovative features are being adopted in the Kai Tak DCS. The innovation features included using three pipes/ring circuit chilled water distribution pipe networks with water leakage detection cable to improve system reliability. The Kai Tak DCS pumps seawater from the stagnant area to serve as cooling water for facilitating water circulation in the harbour area to enhance water quality. Furthermore, natural resources, such as seawater, are adopted to reduce the recovery period.

Advantages of DCS from the experience of Kai Tak DCS

- Highly energy efficient by making use of load diversity, minimising power and energy loss
- Reduce electricity consumption by 20% and 35% as compared with the water-cooled system and air-cooled system respectively
- Provide a reliable source for chilled water
- Mitigate environmental impacts such as heat island effect, noise and vibration nuisance
- Allow for more flexible building design and release space for greenery
- Create jobs opportunities from the design, construction and operation of the project
- Government Role in Implementation of Kai Tak DCS

The Electrical and Mechanical Services Department (EMSD) is the project manager of the Kai Tak DCS. EMSD is responsible for coordinating with the government departments, utility companies and building owners to optimize the system design and operation. Being a DCS promoter, EMSD organised promotion campaigns, including site visits, the Kai Tai DCS Open Day, and presentations to introduce the first DCS in HKC to the public and highlight the growing importance of DCS in combating the climate change challenge. Being a DCS regulator, EMSD established District Cooling Services Ordinance to govern the DCS Tariff, which consists of capacity and consumption charges to cover initial investments and daily energy use. The connection of DCS has been mandated through the additional clauses in the land lease condition.

Future DCS in HKC

With the success of Kai Tak DCS, the Government is planning to implement more DCS in new development areas in HKC. There will be an additional commercial floor area of about 400,000 m^2, a change in the design of the Kai Tak Sports Park with cooling for the stadium having a retractable roof, and an increase in the scale of the New Acute Hospital. The cooling capacity of the existing DCS was designed during the initial development of KTD in 2008, and will not be able to meet the increase in the projected cooling demand. The HKC Government, therefore, proposes constructing an additional DCS at KTD. It is estimated that upon full utilisation, the additional DCS can save about 53 million kWh of electricity annually, with a corresponding reduction of CO2 emission of 37,000 tonnes per annum. Nevertheless, in line with the Government's commitment to low-carbon development, the Government would explore the feasibility of providing DCSs in new development areas such as Tung Chung and Kwu Tung North.

3.4.2. Sharing 2-2: District Cooling System in Thailand

Presenter: Mr Watcharin PACHITTYEN from Department, Alternative Energy Development and Efficiency (DEDE), Ministry of Energy of Thailand, Thailand

Overview of Thailand

Thailand is a tropical region with an average temperature of 30°C. According to the IEA, the energy production, supply, final consumption and CO2 emissions in Thailand has been dramatically increased since 1990. The volume of the air conditioner (AC units) sold in Thailand increases steadily since 2000. As stated in the “National Statistical Office” of Thailand, most of the latest sold air conditioners are installed in factories and service buildings. Hence, the Thailand government decided to promote the conservation of energy by adopting DCS for these buildings.

District Cooling System in Thailand

The Central Utility Plant (CUP) in the central chiller room supplies chilled water via the distribution pipework to the heat exchangers installed at the served buildings to provide chilled water to the Air Handling Unit (AHU). In Thailand, the chilled water in DCS is supplied at 5°C and returned at 14°C. The energy meter is installed in each building to record the cooling energy used, such that the users can measure the power used and energy saved.

Benefits of DCS

There are benefits of DCS and key benefits for Campus and Condominiums are listed:

Campus:

- Minimize capital investments;
- Minimize area of Utility Plant;
- Increase the stability and reliability;
- Minimize impact on the environment by reducing heat, noise, pollution, greenhouse and refrigerant usage; and
- Minimize the growth of the power plant.

Condominium:

- Reduce transformer capacity;
- Reduce the electricity main feeder; and
- Reduce the power distributions.

Example of the Project

Project	Building Types	Gross Floor Area (m^2)	Cooling Capacity (RT)	Status
Government Complex - Chaengwattanna, Bangkok	Multi-office building, convention centre	975,200	12,000	Completed, in operation
Siriraj to Medical Excellence in South East Asia (SIME)	Multi-buildings hospital campus	238,000	6,000	Completed, in operation
The Forestias	Mixed-use complex	750,000	10,000	Design/ Construction
One Bangkok	Mixed Use Complex	1,830,000	38,000	Design/ Construction
New Tobacco Factory	Multi-factory buildings	276,400	6,000	Construction
The Super Tower	Mixed-use complex	320,000	10,000	Design development

3.4.3. Sharing 2-3: Integration of Renewables in District Heating and Cooling

Presenter: Mr Yong CHEN and Mr Jack KIRUJA, International Renewable Energy Agency (IRENA)

Overview of Global Decarbonisation

From 2018-2050, 2.5 billion urban dwellers will be added globally thus increasing the demand for additional energy services. The Paris Agreement sets the target of achieving net zero in 2050, which placed a major challenge for the cities globally to address the decarbonisation target while meeting the growing energy demand. IRENA estimated that Renewable Energy (RE) and electrification make up 75% of emission reduction. The transition of energy supply shall be applied to buildings, transport, industry and district energy sectors for the lion's share of the reductions. Around 80% of cities with renewable energy targets are located in temperate or cold climate zones. The location of the city will affect energy demand, particularly for heating in winter.

Renewables for DCHS

IRENA encourages adopting renewables for DCHS widely. The RE sources for district heating include waste to energy, biomass, geothermal, solar thermal, heat pumps, and waste heat. Moreover, free cooling, seawater, river or groundwater, and solar thermal for absorption chiller are recommended for district cooling.

Technical Guidelines for Development of Bankable Renewable Energy Heating and Cooling Projects

Developed by IRENA, the technical guidelines are to support the development of RE heating and cooling solutions. The technical guidelines covered low-temperature thermal networks, RE technology designs and other key factors for RE project development. The guidelines cover the key consideration in the nine stages of development of the RE project, including identification, screening, assessment, selection, pre-development, development, construction, operation and decommissioning.

Factors for success RE project development

The success of RE project developments relies on the identification of energy risk in the early stage, enhanced capacity and knowledge for the technologies, awareness of city-level decision makers for benefits from RE in DCHS, strengthening institutional collaboration across similar cities, facilitating a predictable and sustained financing model, as well as measuring, evaluating and sharing results.

Case Study –Transformation of Heating Sector in Zhangjiakou in China

Zhangjiakou is a medium-sized Chinese city of 4.4 million people located in northwest Hebei Province, adjacent to Beijing. With its abundant renewable energy resources and excellent skiing conditions, the city was selected to support Beijing in hosting the low-carbon 2022 Winter Olympic Games. Zhangjiakou is abundant in renewable energy resources, including an estimated technical resource potential of 30 gigawatts (GW) for solar photovoltaics (PV) and 40GW for wind, a large amount of biomass and geothermal potential for heat, as well as excellent geological conditions for pumped storage hydropower facilities. In 2015, the State Council of China approved Zhangjiakou City as the economy's first-ever domestic renewable energy demonstration zone. The city has subsequently set near- and midterm renewable energy targets.

In Zhangjiakou, heat consumption, particularly for space heating in buildings, is a major component of the Zhangjiakou energy mix. By 2017, a total of 150 million m^2 of floor area in the city required space heating services. The heating period spans from 1 November to 31 March, or a total of 151 days. Around 95% of space heating services were met by coal, while electricity, natural gas and biomass, categorised in China as clean energy sources, accounted for only 5%. District heating systems and heating systems in building complexes represented around 65% of the total space heating area. By 2017, Zhangjiakou had 3,453 kilometres of district heating networks, including 1,092 kilometres of the main network and 2,361 kilometres of pipelines connecting the main network to heating systems in buildings. Between these two types of networks are 270 heat substations. The entire network covers 61.7 million m^2 of district heating area or 41% of the total space heating area. By 2050, the city could increase renewables from less than half to nearly three-quarters of its electricity mix, IRENA's roadmap report indicates.

By adopting the roadmap, the city of 4.4 million people in Hebei Province sets an example for other cities in China and worldwide to take advantage of renewables. The low-carbon energy plan also strengthened the city's joint Olympic bid with Beijing. This has provided Zhangjiakou with an opportunity to showcase the impressive renewable energy development that it has achieved over the past few years. The transformation of conventional (coal CHP) to RE heating solutions is adopted with actions of concentrating solar thermal (tower) with seasonable energy storage for building complex, scaling up the biomass and geothermal for heating, and surplus renewable electricity for heating through DHS and thermal energy storage.

Highlights for integration of Renewables in DCHS

RE available at local levels such as solar thermal or waste from industry is normally with low temperature. The solutions to enable the integration of low-temperature RE in DCHS networks are introduced below:

- Strategic heating and cooling planning at domestic and city levels with stakeholder engagement for mapping heating and cooling demand with local RE sources.
- To address technical challenges at the existing network at networks and building levels and implement integrated building renovation strategies on building envelop and control equipment, change of human behaviour such as preheating the building and using electronic control equipment, as well as the modernisation of fuel.
- To enable framework, regulatory conditions, financing and business models for DCHS installation and investment.
- Training for specific challenges and solutions for different RE technologies.

3.5. Session 3: Technology and Operation experience

3.5.1. Sharing 3-1: Research and Practices on Standardisation for District Energy System (DES) in China

Presenter: Mr LIU Meng, Deputy Director of Energy Saving Office, China National Institute of Standardisation - Zihuan Branch, China

Necessity of District Energy System (DES) Standardisation

DES is one of the key areas of the 2016 G20 Energy Efficiency Leading Programme. DES could have a market size of over a hundred billion USD. The rapidly growing market of DES brings both positive and negative impacts. Although the DES market attracts capital and investment, the other hand, due to the lack of technical regulation standards and supporting policies, it is challenging to ensure the energy performance of the DES project. Hence, driven by both international initiative and domestic policy, the standardisation of DES is a critical tool for the development of DES.

Development of DES Standards

"China National Institute of Standardisation" (CNIS) has developed various DES standards, which consist of seven parts such as fundamental, planning, design, construction/installation, technology/product, operation and assessment, and cover the combined cooling, heating and power plant, DES, smart DES, distributed resources interconnected with power grid etc.

Other works by CNIS

Besides formulating the standards, CNIS also worked on the data collected from over 100 CCHP projects in China (2,200MW capacity), on-site investigation on CCHP, residual heat recovery and smart DES in different industries or buildings. In addition, international cooperation and capacity building were carried out for exchanging opinions from international experts through an international forum such as the 8th Clean Energy Ministerial (CEM8) and plenary meeting of the ISO Technical Committee (ISO/TC301) in 2017.

Case Study - DES Standard Application in China

China has implemented two demonstration projects of smart DES, namely the new development in the Sino-Germany Ecopark in Qingdao and retrofitting the existing systems in the Ecopark in Langfang, Hebei Province.

Sino-German Ecopark is the first demonstrative cooperation project for sustainable development jointly developed by the Chinese and German governments. It is situated in Qingdao West Coast New Area, the 9th new area of China and located to the south of Jiaozhou Bay Expressway, the northeast of Xiaozhu Mountain Scenic Area, and the north of Muma Mountain Ecological Corridor. The Ecopark has a planned area of 11.6 km^2, a reserved area for future expansion of 29 km^2, and a long-term planned area of 66 km^2. Focusing on the formulation and application of ecological standards, the planning and development of low-carbon industry, and the construction and promotion of a green city, the park gives priority to such green industries as energy saving and environmental protection, green energy, environmentally friendly materials, such emerging industries as high-end equipment manufacturing, new energy application, digital science and technology, smart system, and modern service industries such as sci-tech R&D, planning and design, education and training, finance and medical treatment, as well as culture and sport. Sino-German Ecopark has been rated as a domestic low carbon pilot city, domestic demonstration zone for intelligent manufacturing, the first domestic comprehensive standardisation demonstration zone, green manufacturing international innovation park, smart city pilot zone, green and ecological demonstration zone, and one of the first new energy demonstration zones and is a recipient of living environment award.

Ecopark in Langfang is located in the northwest of the Hebei province in China. The Ecopark has a planned area of 80 km^2, with ten km^2 as a start-up zone. This Ecopark included a wetland park fed by its water reservoir at the southern part of the Ecopark. Phase I works with the water reservoir was completed in 2013. The target tenants of Ecopark are high-tech commerce, financial, IT and healthcare industries. The Ecopark is equipped with power, water and heat supply stations, gas regulating station, communication infrastructure, as well as sewage and rubbish treatment facilities to improve the city's ability.

Both projects have proved a successful application of DES standards with the complicated DES incorporating renewable energy and clean fossil energy, coupled with IoT control and trading, enabling smart control and trade.

3.5.2. Sharing 3-2: Two Decades of DCS Implementation in Hong Kong, China

Presenter: Mr Vincent CHENG, Hong Kong Green Building Council, Hong Kong, China

Demand for DCS in Hong Kong, China

Like most urbanised cities, Hong Kong, China (HKC) is moving fast and aggressively in carbon emissions. To align with the Paris Agreement, the HKC Government introduced the "Hong Kong Climate Action Plan 2030+", urging the city to take actions to realize carbon emission reduction by 2030. Since building accounts for 90% of the electricity consumption while a large portion of it is contributed by air conditioning, reducing cooling energy demand is the priority to achieve carbon reduction. Studies have found that the district cooling system (DCS) can help to improve energy efficiency. The government has explored the feasibility of providing DCS in various new development areas.

Kai Tak DCS – Challenges

DCS at Kai Tak District uses direct seawater for heat rejection of three centralised cooling plants and then supplies chilled water to user buildings in the area through a network of pipes. As the first practitioner of DCS in HKC, the project team of Kai Tak DCS faced numerous issues during the early planning and design stages in the following aspects:

- Environmental issues (temperature elevation, residual chlorine and residual biocide in the water in the area)
- Institutional and regulatory issues (land, development programme, design and technology, operation arrangement, contract strategies and charging mechanism)

Kai Tak DCS – Implementation

Public Private Partnership (PPP) is considered a suitable procurement method as it reduces the risk for either public or private sector and avoids the possible monopoly in the industry. Kai Tak DCS adopt Design-Build-Operate (DBO), where the government is responsible for funding and the contractor is liable for design, construction and operation. The tariff is negotiated by the owner and the contractor to pay back the initial capital cost.

Kai Tak DCS – Tariff

The initial investment in the project is to be paid back through a fair and transparent tariff. The tariff is calculated using Life Cycle Cost (LCC) methods considering the cost and possible revenues under a range of demand scenarios. The tariff is proven to be financially viable by benchmarking with the cost of commercial AC units.

Kai Tak DCS – Engineering Challenges

Engineering challenges are unavoidable during designing, constructing and operating the first DCS plants in HKC.

Design phase:

- High-efficiency system design with accurate energy model, seawater cooling system, chiller selection, heat exchanger design
- Reliable system design with a standardised connection mechanism, three pipes/ring circuit design and water leakage detection system
- Selection of chillers based on capacity, market availability, refrigerant, etc.

Construction phase:

- Site constraint for the extensive construction works for DCS plants and pipework alignments, such as interfacing issues and complicated ground conditions
- Trenchless approach for pipe installation under a congested built area

Operation phase:

- Extensive testing and commissioning process to ensure the system will run as designed performance
- Operation of the whole DCS system is realised through a smart automatic computerised system

3.5.3. Sharing 3-3: Disconnect between District Cooling System Provider & User: Need for an equitable & sustainable solution

Presenter: Mr Thiam Leong CHEN, Past President of the Malaysian Chapter of ASHRAE of Malaysia, Malaysia

Synopsis

The technical and economic advantages of DCS are unquestionable when designed and implemented properly. Unfortunately, in protecting their financial returns, the DCS providers often tend to impose impractical and unilateral performance conditions for users. Such inequitable terms and conditions have been simmering over the years in the industry.

Disconnection between DCS Provider and User

Users consider adopting DCS with the benefits of saving the space of the central chiller plant room with better aesthetics, reducing both the initial cost and the life-cycle cost, relieving the operation and maintenance of the central chiller plant, as well as enhancing cooling system redundancy. Meanwhile, DCS providers expect the Return of Investment (ROI) is to be derived from utility charge which includes connection fee, fixed capacity charge and monthly energy charge which made up of maximum demand charge and variable energy charge.

A summary table with eight examples of Malaysia's DCSs charges in 2010 shows that the DCS tariff varies widely among the DCSs. Only one of the DCSs offers an "Off-peak" tariff.

By adopting DCS, the DCS users expect favourable life cycle costing, fair tariff rate, real space-saving, no impact on the standard airside system design connection to minimise the cost impact on space and maintenance, reward schemes on the user's energy efficiency practice and similar of terms and conditions provided by the DCS providers compared with the electricity providers. Taking tariff in Malaysia as an example, the DCS tariff has a much higher proportion of maximum demand charge than variable energy charge compared to the electricity tariff. Moreover, the electricity providers allow users to re-declare the maximum demand charge after a prescribed period noteworthy for DCS providers.

At this point, DCS providers and users should be interdependent. However, DCS provider tends to dominate in the relationship. Instead of serving as service providers, DCS providers impose one rule for all users who cannot comprehend the cutting-edge thought. One of the disconnections between the DCS providers and users is the non-transparency from one side begetting the same from the other side.

The current mechanism of DCS providers' maximum demand charge adopted in Malaysia stifles innovation and discourages energy efficiency practices on the users' side. To learn from other utilities, DCS providers should consider formulating meaningful 'sustainable' off-peak tariff charges and alternative tariffs to suit different building typologies with exceptional cases. To bridge the disconnection, DCS providers should arrange regular and transparent discourse with users and design professionals for keeping the stakeholders' up-to-date information.

Three disconnection examples are given for sharing:

- Case 1: Design & Specification

    - Disregarding the building typologies, lower-rise building users are compelled to use a high-pressure heat exchanger for inherent system design as high-rise building is decided by the providers. This may cause the users to oversize the equipment with extra equipment and accessories costs.
- Case 2: Design & Penalty disconnect
    - Disregarding the building typologies, for example, buildings using fan coil units, there is a penalty to the user for the chilled water temperature compliance but an incomprehensive penalty on the DCS provider side.
- Case 3: Discourage Adoption of Energy Efficiency and Cutting Edge Technologies
    - Rigid and perpetual maximum demand charges with meagre variable charges imposed by DCS providers discourage the attempt to carry out energy efficiency improvements. Regarding the cutting-edge technologies brought up by the users, DCS providers refuse to understand and share financial advantages to be gained.

Proposed Sustainable Solutions

- Maximum Demand Charge:
    - Providers shall dispense with perpetual maximum demand charge and countenance re-declaration of maximum demand after the initial period with capital cost recovered. The penalty can be considered when maximum demand use exceeds the re-declared value to prevent re-declared maximum demand. Subsequently, to further encourage continuous energy efficiency practice, users shall be billed according to the Maximum Demand Charge can be pegged at 70% to 80% of the re-declared maximum demand.
- Variable Energy Charge – temperature difference resolution:
    - Providers shall consider providing customised design installation options for end-users to safeguard the operating cost due to the low-temperature difference. Providers can introduce a reward-penalty factor for temperature differences in variable energy charge and encourage the end-users to optimize the temperature difference for energy efficiency practice.

3.6. Session 4: Global experience and Challenges

3.6.1. Sharing 4-1: International District Energy Experiences - from Asia Pacific and beyond

Presenter: Mr Mikael JAKOBSSON, Executive Director of Asia Pacific Urban Energy Association

Overview of Energy Market in the Asia Pacific Region

The energy market assessment conducted has pointed out that energy demands in space cooling in India and China are expected to be most significant in 2050. Besides, there would also be a growing demand in Indonesia. Thus, district cooling would be a good opportunity in these Southeast Asian economies.

Unique characteristics of energy consumption in different cities have been observed, for example, the commercial sector accounts for the largest energy share in Hong Kong, China while the transportation sector consumes the most energy in Bangkok. Asia Pacific Urban Energy Association (APUEA) has studied the energy market characteristics to facilitate the district energy application in the Asia Pacific region.

Advantages of District Cooling and Heating Systems

In general, the benefits of a district energy system are as below,

- Reduce pollution from dense urban areas, especially for district heating system

- Decrease in installed capacity
- Increase in system efficiency
- Improve safety and reliability
- Utilize multiple sources
- Co-generation and Tri-generation
- Reduce the heating island effect

On top of the above traditional benefits of district energy, additional modern benefits of DCS are summarised below.

- Utilise local resources
- Increase utilisation of renewables
- Hydrofluorocarbon (HFC) phase-down
- Integrate energy storage systems to improve the system efficiency and flexibility and enable energy symbiosis.

Difficulties in Implementing District Cooling

Despite the known benefits of district energy, there is scepticism about the feasibility of DCS in the market:

- Expected low operational efficiency (high losses)
- Cross-sectoral complexity
- Insufficient Urban/Energy planning practices
- Absence of experienced utilities
- Front loaded investments
- Lack of comprehensive and consistent regulations
- Bad implemented/operated examples
- Low grade of utilisation due to residential user behaviour

Future of DCHS

Many district heating systems are applied to a city, but the district cooling system scale is smaller. With the electrification of heating system equipment, there is a potential of scaling down the district heating system.

For promoting DCHS, the definition of "district" shall be separated from the "centralised" system. For example, the cooling system application in an airport or hospital shall be a kind of centralised cooling/heating system instead of a district system.

Great potential for DCS in Asia Pacific Region

The Asia Pacific region is the largest growing cooling market in the world. The potential of DCS in the Asia Pacific region is inevitable. With the recognition by international energy organisations, including APUEA, UN DES, K-CEP, and the promotion of sustainable energy development, there are countless business opportunities in the district cooling utility business in light of many economies and companies are ambitiously looking for strategies to combat climate change.

3.6.2. Sharing 4-2: Your Partner in District Cooling Systems (DCS)

Presenter: Ms Anh-ha de FOUCAULD, Head of District Cooling Schemes of ENGIE South East Asia

Working Principle of District Cooling Systems (DCS)

The general principle of DCS is to deliver chilled water produced by the centralised chiller plant through various automated transfer stations and eventually serve the secondary chilled water networks to each building in the supply district. The chilled water circulated in a closed loop with a supply temperature of 3°C and a return temperature of 12°C. Energy storage and ice storage tanks are provided to balance the production and consumption of chilled water, saving energy during peak hours and ensuring the continuous supply of chilled water. The chilled water network is monitored and controlled 24/7 from the control room. If the city is near a local water resource, like in Paris, the return water in circulation can be directly cooled by the local water source. This could further reduce the cooling energy, enhance the system efficiency and reduce the urban heat island effect.

Key benefits of DCS compared with the conventional chilled water production system

- Highly energy-efficient and cost-effective
- Reduce electricity and water consumption
- Reduce heat rejection in the cities and mitigate Urban Heat Island effect
- Free up the valuable rooftops and building spaces for other usage
- Lower CO_2 emissions for moving towards zero-carbon and attract new businesses into the city

Recommended Policy and Financial Support

There are challenges in DCS development and measures to support the development of DCS have been proposed. The city authorities play a fundamental role as regulators and market facilitators when initiating DCS. To promote the growth of the DCS market, policymakers can provide an incentive to attract developers and promote the competitive advantages of DCS compared with the stand-alone system. Different financing structures shall be investigated for DCS projects, including public investment and incentives, SPV with the public sector and wholly private financing.

Sharing from Brownfield DCS in The Philippines

Several DCS projects referenced in Europe, the Middle East and South-East Asia region have been introduced with special highlight to the first Brownfield DCS project in the Northgate Cyberzone of The Philippines, providing DCS for 12,000RT cooling capacity for over 16 buildings. The capacity of chilled water production and the length of the network are sized to meet the exact demand of the buildings. This will ensure customers are not overcharged for any oversized systems and allow city planners to better forecast city requirements.

3.6.3. Sharing 4-3: District Cooling, Key Component in Sustainable Districts, Now and Prospects

Presenter: Mr FOO Yang Kwang, Chief Engineer from the Sustainable Energy Solutions team, SP Group and Senior Vice President of Singapore District Cooling Pte Ltd, Singapore

The Objective of Implementing District Cooling

Reference was made to the International Energy Agency (IEA) findings for actions to achieve the United Nations Sustainable Development Goals (SDG), which are by enhancing energy efficiency and renewable energy. It was estimated that implementing the district cooling system can play an important and useful role in supporting SDG initiatives.

Advantages of District Cooling that experienced in Singapore

- Economic of Scale through aggregation

- Superior energy efficiency through the integrated operation
- Enhanced reliability with more focused O&M and higher skill level O&M staff
- Enhanced electricity grid stability by DCS with thermal energy storage when incorporated with renewable energy

Difficulties for Implementing District Cooling

- Mainly implemented in new districts
- Challenging to implement in "silo" (stand-alone) buildings in the existing district.

Future of Implementing District Cooling

- To develop DCS as a key building block of sustainable and smart energy district.
- Proven benefit from DCS in commercial set-up in Marina Bay, residential is the next frontier for DCS.

Highlights for implementing DCS

- Minimize installation of unnecessary equipment hence economising resources used and carbon footprint
- Minimize refrigerant deployment to reduce uncontrolled emissions to the atmosphere, especially for residential projects
- Facilitate incorporation of promising sustainable technology due to scale.
-

Sharing from Marina Bay DCS in Singapore

1. *DCS Network Development – Flexibility and Expansion*

From the experience of Marina Bay DCS, it is found that the accuracy of demand estimation is not critical to the DCS implementation, but phasing of DCS plant is important for having highly feasible to enable the development of DCS in brownfield areas with multiple "silo" existing buildings with different load operation.

DCS Plant No1		DCS Plant No2		Satellite Plant No1
Commissioned in May 2006		Commissioned in May 2010		
Ultimate capacity: 157MWr		Ultimate capacity: 180MWr		Connected in Feb 2013
Installed capacity: 97MWr		Installed capacity: 120MWr		Installed capacity: 10MWr
2006	→	2010	→	2013

Pipe Network in Common Services Tunnel

Table 4-1"Timeline for Green Field Implementation of Marina Bay DCS"

2. *Unique DCS Regulatory Model*

Energy Market Authority (EMA) in Singapore develops the DCS regulatory framework ensuring full transparency of costs, responsiveness and availability. In Singapore, there is a lack of land for large DCS plants. Therefore, several large-scale developments are required to form the co-located DCS plant with DCS as a mandated utility service. Moreover, the DCS tariff is regulated by EMA in Singapore and the DCS operator cannot charge higher than the regulated rate. The DCS tariff is set to be lower than the cost of in-building chilled water production.

Current development of DCS in Singapore - DCS for Residential District

Singapore experienced a rise in cooling demand with an increased number of homes. Brownfield contains a large portion of buildings in Singapore. Singapore is currently developing the first residential DCS project in the Tengah Residential District, which includes 220 residential blocks of 22,400 homes. Individual buildings in the district are interconnected with pipework and a control system for optimizing the usage of the connected chillers. Like the residential district connected with the chilled water network serving schools, community centres and retails in the district, this would smooth the cooling load peak in the district. A positive response from the residents is received with a high subscription rate.

3.6.4. Sharing 4-4: Applications of District Energy Systems in the United States

Presenter: Mr Cary N. BLOYD, Senior Staff Scientist in the Electricity Infrastructure & Buildings Division of Pacific Northwest National Laboratory, the United States

District Energy in the United States

Over 660 district energy systems are operating in the United States. The district energy systems are typically applied in university or college and research campuses, hospitals, military bases and airports, and in areas of dense building settings, such as central business districts of larger municipalities.

The U.S. Department of Energy (DOE) and its Buildings Technology Office (BTO) are dedicated to district energy research investigating the energy efficiency benefits, energy market, implementation challenges and energy security of district energy.

In the private sector, district energy systems are supported by the International District Energy Association (IDEA). The IDEA is dedicated to promoting district energy by conducting a wide range of case studies, providing virtual learning with live and streaming webinars and holding annual conferences.

Sharing from the University of Texas Austin Campus in the United States

The campus applied district energy with Combined Heat and Power system (CHP) and microgrid, to provide heating and cooling for the campus since 1929. The district energy system provides 100% of the electricity supply to the 160 buildings on the campus.

Tools - Advanced Analytical Platform - URBANopt

The "National Renewable Energy Laboratory" (NREL)'s provided with an advanced analytical platform called URBANopt, to allow users to investigate energy efficiency and renewable energy at the district scale and identify strategies for optimizing building and energy system performance within one geographically cohesive area within a city (e.g., a city block or district)

Future Research for District Energy

The NREL is continuously investigating the future technologies and opportunities of the district energy system. The following shows some of the future research areas:

- The ability of CHP and district energy to provide balancing and stability services to the electric grid to support the integration of intermittent energy resources
- Enabling technologies, energy master planning

- Quantifying non-energy benefits of district energy use
- Management of load curtailment and system deployment during weather-related interruptions or conditions of grid strain

3.7. Closing remarks

Presenter: Mr VY Ek Chin, Expert Group on Energy Efficiency and Conservation (EGEEC) Chair

The workshop covered a wide range of topics from data collection strategy, DCHS development in different economies, technology and operation experience, global experience sharing and challenges. Through the discussion, the participants gain more understanding of the application of DCHS technology and recognise the importance and benefits of DCHS from the EE&C perspective.

Due to COVID, governments need to take further actions to protect citizens' health and well-being. Leaders are facing the economic impact of the crisis and think ahead on strategy for quick economic recovery in post COVID era. With the labour-intensive nature of the EE&C industry, such as manufacturing and construction, governments shall consider DCHS as a win-win solution to create jobs and boost the economy in the short and medium terms.

There is no doubt that HKC will continue to promote EE&C for all APEC member economies. APEC member economies shall strengthen energy cooperation to achieve APEC's aspirational target to reduce aggregate energy intensity by 45% by 2035 through collaboration and sharing of the latest energy technology, energy efficient standards and peer review.

3.8. Summary of Discussion

Q1: Would Mr Yong CHEN share with us more about the life cycle analysis of adopting RE in DCHS?

Mr Yong CHEN: We are going to have a technical guideline for renewable energy and heating and cooling. It will be ready in December 2020 and will be uploaded to the website and made available to the public.

Mr Jack KIRUJA: IRENA is developing guidelines for district heating and cooling with RE, which will be a guidebook for policymakers. That will highlight some of the tools and options that are available for integrating low-temperature RE, which covers all the stages including life cycle analysis for adopting RE in DCHS. The guidelines are going to be translated into Chinese, Spanish, and Russian.

Q2: Would Mr TL CHEN share more about the formulation of variable energy charges in Malaysia?

Mr TL CHEN: The district cooling tariff is not regulated in Malaysia. Although we had DES installation for over 20 years, it is fine to charge variably. The formula I propose cannot be renewed every year if the contract is signed. The base charge rate would be dependent on fuel use. So, there is always adjustment with the prevailing fuel suppliers. The formula I propose is based on the affinity laws and Singapore also has its formula on variable energy charge.

Mr FOO Yang Kwang: In Singapore, equitability is important for all parties. For example, the user's area is allowed to modify the cooling contractor capacity five years after subscription. There is no lock-in as the usual practice in the Middle East or elsewhere in the world. To address the low return temperature issue, a monthly surcharge will be imposed if the return temperature is below the required temperature. For every degree, there is a 3% surcharge on usage. Since we are mindful of the equitable principle, in return, we need to guarantee the quality of supply. If the average hourly chilled water supply temperature is above 6.5 degrees, we will forego that one hour of contract capacity charge.

4. Conclusion

Experts and practitioners among the APEC member economies have shared planning, design, operation and regulation of the DCHS during the workshop. The growing importance of DCHS from the perspective of energy efficiency and conservation through the collection of DCHS data in driving progress toward meeting the energy intensity reduction goal of APEC was highlighted in the workshop. DHS is widely adopted in temperate climate regions, particularly the northern parts of the United States; Japan; China etc. The popularity of DCS has been growing in the sub-tropical climate area, including Singapore; Hong Kong, China; Malaysia etc., with cooling capacity reaching 25GW in the APEC region.

From the sharing and discussion during the workshop, case studies among the APEC member economies have demonstrated that the deployment of DCHS is encouraged for its proven and cost-effective solution to reduce energy consumption and peak load cooling or heating demand. With grouping chiller plants or boilers, chilled water and/or hot water can be supplied through the district-wide pipe networks to the building users. With the benefit of a high coefficient of performance (COP) of a large-capacity chiller or boiler and plant operation optimisation by load sharing, the efficiency of the DCHS plant can be improved by supplying cooling or heating services to a group of buildings. Moreover, several benefits can be obtained from the system in addition to energy consumption reduction, including heat rejection and noise generated from the cooling tower and/or air-cooled chiller, as well as free up plant room space for more flexible architectural design. DCHS will become an energy-efficient infrastructure system, through synergy with micro-grid and smart city technology, contributing to the Advancing Net Zero (ANZ) strategy of the entire city.

Building capacity of the DCHS by exchanging experiences with regulators, international organisations, experts, designers and operators of DCHS in the design, construction and operation of the DCHS plant during the workshop is vital in promoting the broader use of DCHS among APEC member economies. The hesitation in using DCHS was mainly due to the lack of technical support in design and operation, as well as the implementation strategy and long-term operation of the large plant. Lessons learnt and successful cases can be the reference for the economies' planning to adopt this energy-efficient infrastructure system.

Countless solutions have been identified at the workshop to improve efficiency, realise carbon reduction and improve the cost-effectiveness of DCHS. From a technical perspective, engineers and designers can consider adopting the following measures when planning and designing DCHS:

- Make use of diversified cooling and heating load and frequency of load occurrence profile in optimising the equipment configuration
- Improve the central plant efficiency through Combined Cooling, Heating & Power (CCHP) and heat recovery technology, such as heat pump
- Trim down peak cooling load and optimise equipment installed capacity, increase system resilience and reduce plant operation cost by adopting thermal storage, in particular for districts with peak and off-peak electricity tariff
- Integrate renewable energy, such as photovoltaics technology, to offset carbon emission
- Adopt seawater cooling to increase the overall DCHS COP, as well as to reduce the heat island effect by reducing heat rejection in the ambient air

- Ring pipe network design with leakage detection to prevent a single point of failure and ensure the reliability of the system

Employ a highly skilled operation and maintenance team to carry out regular and frequent maintenance and resource planning, as well as free up plant-room spaces of individual buildings for other purposes.

Besides, policymakers and regulators shall establish a sound and organised market as well as standards for a healthy competitive environment to realize the benefits of DCHS. The frameworks and regulations to be considered are summarised below:

- Mapping heating and cooling demand and DCHS block load annual profile to identify the viability of adopting DHCS
- Public-Private Partnership with a design, build, operation and transfer model has been proven to be useful to engage service providers
- Establish and improve regulations and standards on technical design through data feedback from existing plants
- Transparent tariff scheme in terms of maximum demand charge, variable energy charge with reward and penalty to encourage continuous energy saving from end-users as well as to ensure a more stable return temperature from end-users
- Provide training and share experiences with the stakeholders involved, including designers, service providers, operators and maintenance personnel.

According to APERC's report, it is revealed that the data collection for DCHS plants shall be improved by standardising the parameters and methodology. The energy consumed for the supply of heating or cooling services from the DCHS plant to the building shall also be included in the building Energy Use Intensity (EUI). For further implementation of DCHS, a closer collaboration between stakeholders shall be carried out to develop methodology, guidelines and regulations for the data collection for DCHS.

Through the workshop, the regulators, international organisations, experts, designers and operators of DCHS shared the experience and best practices with the participants from APEC member economies. Roadmap and actions to implement the DCHS, ranging from strategic heating and cooling planning at domestic and city levels with stakeholder engagement for mapping heating and cooling demand, addressing technical challenges for having a network at existing buildings, implementing integrated building renovation strategies on building envelope and control equipment with the adoption of DCHS in existing buildings, modernising of fuel and heating equipment, to enabling installation and investment of DCHS by having technical standards, regulation and financing framework, are recommended to the policymakers and regulators.

With the growing cooling demand in the APEC member economies, DCS shall be promoted as a cost-effective solution for air conditioning. In light of the technology of DCHS that has become mature in recent years, there is great potential to adopt DCHS to a wider extent. According to SP Group, Singapore, apart from the standard application of DCHS in the commercial district, it is feasible to implement DCHS in the residential neighbourhood by connecting schools, community centres and retails to smooth the cooling load peak. Besides, with the limited land available in urbanised cities, DCHS shall also be considered for dense brownfield development.

To derive more benefits from the DCHS plant, the IRENA suggested integrating the renewables into DCHS. It is recommended to adopt free cooling, cooling by seawater, river or groundwater, as well as heating by solar thermal, absorption chiller or waste heat.

From the experience sharing and direct dialogue at the DCHS workshop, a great potential for implementing DCHS in the APEC region was identified, with the readiness of technology and case references in solving challenges faced, sufficient technical support, a comprehensive list of actions for the regulators to implement DCHS in a district, as well as directions for further development in standardising data collection and integration of RE in DCHS for enhancing analysis opportunity and benefits resulting from the adoption of DCHS.

Appendix A - Workshop Agenda

APEC Workshop on District Cooling and Heating Systems Virtual Workshop on 17 November 2020 (Tuesday)	
AM (HKC time)	**Details**
08:30 - 09:00	**Registration, Preparation and Testing of Online System**
09:00 - 09:10	**Welcome Address** by Hong Kong, China
09:10 - 09:20	**Opening Remarks** by EGEDA Co-Chair
09:20 – 09:35	**Sharing 1 - A Study on District Cooling Systems in APEC: The Final Report** by Ms Elvira Torres GELINDON from ESTO/APERC
09:35	**Photo taking**
• **Development of DCHS**	
09:35 – 09:50	**Sharing 2-1: Planning & Implementation of District Cooling System in Hong Kong, China** by Ms Denise LO Kit Ying, Senior Engineer, Electrical and Mechanical Services Department, the Government of the Hong Kong Special Administrative Region, Hong Kong, China
09:50 – 10:05	**Sharing 2-2: District Cooling System in Thailand** by Mr Watcharin PACHITTYEN from Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy of Thailand, Thailand
10:05 – 10:20	**Sharing 2-3: Integration of Renewables in District Heating and Cooling** by Mr Yong CHEN and Mr Jack KIRUJA from IRENA
• **Technology and Operation experience**	
10:20 – 10:35	**Sharing 3-1: Research and practices on standardisation for District Energy System (DES) in China** by Mr LIU Meng from China National Institute of Standardisation of China, China
10:35 – 10:50	**Sharing 3-2: Two Decades of DCS Implementation in Hong Kong** by Mr Vincent CHENG from Hong Kong Green Building Council, Hong Kong, China
10:50 – 11:05	**Sharing 3-3: Disconnect between District Cooling System Provider & User: Need for an equitable & sustainable solution** by Mr Thiam Leong CHEN as Past President of the Malaysian Chapter of ASHRAE of Malaysia, Malaysia
• **Global experience and Challenges**	
11:05 – 11:20	**Sharing 4-1: International District Energy Experiences - from Asia Pacific and beyond** by Mr Mikael JAKOBSSON of Asia Pacific Urban Energy Association
11:20 – 11:35	**Sharing 4-2: Your Partner in District Cooling Systems (DCS)** by Ms Anh-ha de FOUCAULD of ENGIE
11:35 – 11:50	**Sharing 4-3: District Cooling, Key Component in Sustainable Districts, Now and Prospects** by Mr FOO Yang Kwang, Chief Engineer from the Sustainable Energy Solutions team, SP Group and Senior Vice President of Singapore District Cooling Pte Ltd, Singapore
11:50 – 12:05	**Sharing 4-4: Applications of District Energy Systems in the United States** by Mr Cary N. BLOYD, Senior Staff Scientist in the Electricity Infrastructure

APEC Workshop on District Cooling and Heating Systems Virtual Workshop on 17 November 2020 (Tuesday)	
	& Buildings Division of Pacific Northwest National Laboratory, the United States
12:05 – 12:25	**Plenary Session & Discussion**
12:25 – 12:30	**Closing remarks** by EGEEC Chair
12:30	**Close of Workshop**